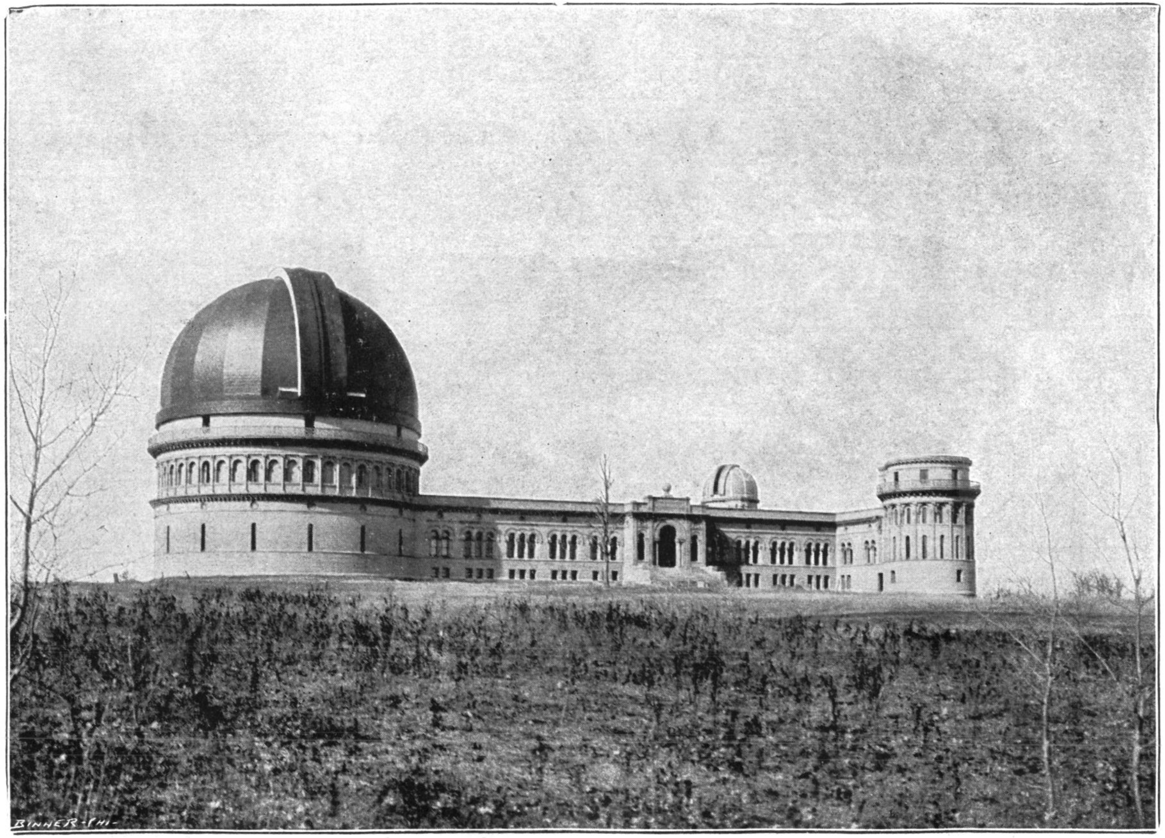

THE SOUTH FRONT OF THE YERKES OBSERVATORY.

BEFORE THE ERECTION OF THE SOUTHEAST DOME.

PUBLICATIONS

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THE YERKES OBSERVATORY.

BY WILLIAM J. HUSSEY.

The Yerkes Observatory has been dedicated, and its active existence as a scientific institution commenced. On the 21st of October, within the great dome, and in the presence of a large assemblage, the donor, Mr. CHARLES T. YERKES, formally presented the observatory and its great telescope to the University of Chicago, and they were formally accepted for that institution by Mr. MARTIN A. RYERSON, the President of the Board of Trustees.

The dedication of this observatory is an important scientific event of the year, inaugurating, as it does, the work of a great institution devoted to the discovery and teaching of scientific truth, and forming an epoch in its history by separating the period of construction, which has extended over the past five years, from the period of its scientific activity, which is just beginning. The dedication was made the occasion of a large gathering of astronomers and scientific men, and a series of conferences on astronomical and astrophysical subjects, with discussions and laboratory demonstrations of new and interesting phenomena, was held at the observatory during the three days preceding the formal exercises. These exercises were held in the great dome of the observatory on October 21st, and were continued in Chicago the following day. The leading address at the observatory was by Professor JAMES E. KEELER, on "The Importance of Astrophysical Research and the Relation of Astrophysics to other Physical Sciences." Other addresses were made at this time, by Mr. YERKES, in presenting the observatory

to the university; by Mr. RYERSON, in behalf of the Board of Trustees in accepting it, and by President HARPER, in behalf of the faculty. In Chicago, Professors MICHELSON and STRATTON gave brilliant demonstrations with new forms of physical apparatus, having possible applications to the solution of certain pending problems of astronomy. In the afternoon, Professor NEWCOMB delivered his address at Kent Theater, on "Aspects of American Astronomy," and that evening, in conclusion, Mr. YERKES provided a banquet for the visiting scientists.

The Kenwood Observatory and the Yerkes Observatory are so related, that an account of the latter would be incomplete without some mention of the former, and in historical order the former comes first.

The Kenwood Astrophysical Observatory had its beginning in a spectroscopic laboratory, which Professor GEORGE E. HALE erected in Chicago in the spring of 1888. In the winter of 1890–91, extensive additions were made to this, converting it into an observatory proper, with an equipment designed especially for the study of solar phenomena by spectroscopic and photographic methods. The observatory was provided with an equatorial telescope of 12.2 inches aperture. The mounting, which was made by Messrs. WARNER & SWASEY, was large and heavy, and was designed to carry a very large spectroscope. The objective and the spectroscope were made by Mr. BRASHEAR. In connection with the observatory a workshop was fitted up, supplied with such machinery and tools as were necessary for the construction, repair, and modification of apparatus.

Professor HALE was not long in obtaining important results with his new equipment. Early in April, 1891, soon after the telescope had been set up, he succeeded in photographing the spectra of the solar chromosphere and prominences for the first time without an eclipse. Within a year or two, he had discovered new lines in the spectra of the prominences, spots, and faculæ; had obtained photographs of the prominences with the H and K lines and an open slit; had matured his invention of the spectroheliograph and had one constructed by Mr. BRASHEAR, and by its use had secured photographs of all the prominences visible around the entire circumference of the Sun at a single exposure, and then, by a second exposure, had obtained on the same plate the forms of the regions on the Sun's disk, even in its brightest parts, over which the H and K lines are reversed, and had shown that these

forms are identical with the forms of the faculæ obtained by photographs taken in the ordinary way.

At the time of its opening, in the fall of 1892, the University of Chicago was entirely without facilities for research in astronomy and astrophysics. Through the care of Professor HALE and others, the matter received the immediate attention of President HARPER and the Board of Trustees, and in a very short time they had obtained from Mr. YERKES an expression of his willingness to defray the entire cost of a large telescope.

Some years previously a large telescope was planned for the University of Southern California. Large disks of glass for the objective of this instrument were ordered from MANTOIS, of Paris, and, when they were made, were forwarded to the opticians, Messrs. ALVAN CLARK & SONS, Cambridgeport, Mass. This is as far as the matter went. The order to finish the objective never came. In 1892 these disks still remained in the shops of the opticians, and were then for sale. When Mr. YERKES was informed that these large disks of excellent glass could be obtained immediately, he authorized their purchase for the University of Chicago, and entered into a contract with Messrs. ALVAN CLARK & SONS for finishing an objective from them. He also made a contract with Messrs. WARNER & SWASEY for an equatorial mounting for the telescope that bears his name. It thus came about that, within a few weeks from the time his gift was announced, the orders for the objective and for the mounting had been given. Mr. YERKES then wrote to President HARPER: "I have felt it proper that the telescope should have a home, to be paid for by me; and I have concluded to add to my gift an observatory necessary to contain the instrument."

A site for the new observatory was not selected immediately. Professor HALE was chosen Director, and the equipment of the Kenwood Observatory was presented to the University of Chicago, to become a part of the Yerkes Observatory. It appeared to Professor HALE that the exceptional instrumental advantages of the new observatory should not be wasted by a mere duplication of the work done equally well elsewhere, and that the large telescope should not be employed in the observation of objects within easy reach of smaller instruments. Notwithstanding the number of observatories that had been established in various parts of the world, and the importance of the subject, comparatively little attention was being devoted to the phenomena presented by

the Sun. He accordingly outlined a plan of work, in which the study of solar phenomena in all phases, and on a more extended scale than had been possible with the equipment of the Kenwood Observatory, formed an important part.

The great size of the telescope, its light-grasping power, and long focal length make it especially suitable for the measurement of faint and difficult objects, for the study of planetary markings, and for the spectroscopic observation of the stars. These considerations led to the inclusion in the plan of work of micrometric observation of difficult double stars, nebulæ, planets, satellites, comets, and stellar spectroscopy. Stellar and nebular photography, meridian observations, and various kinds of laboratory work of an astrophysical character were also included in the plan.

Professor HALE next considered the requirements of the various kinds of work intended to be pursued as dependent upon the quality of the seeing, the transparency of the atmosphere, the blackness of the sky, and the steadiness of the instrument used. After a study of the requirements, he wrote as follows concerning the selection of the site: "It is evident that in these various classes of work, the greater part do not require very good seeing; but on account of the importance of the double-star observations, and those of planets, satellites, the structure of the photosphere, etc., it was eminently desirable to choose a site at which the seeing would be the best attainable by night and by day. Some of the other researches demand a dark sky and great transparency of the atmosphere, while for still others the principal requisite is complete protection of the instruments from vibration of any kind. If there had been absolute freedom of choice, a site combining the excellent conditions for night work enjoyed at Mt. Hamilton with the good day seeing existing elsewhere would have been sought far and wide, without regard to geographical boundaries."

From a consideration of the plan of work, and the conditions necessary for the most successful prosecution of certain lines of it, it was at once apparent that Chicago, or any place in its immediate vicinity, would be an unsuitable location for the observatory. When this became generally known, numerous offers of land and other inducements to secure the observatory were made by individuals and by towns in various parts of the country. A practical consideration of no small weight in determining the location of the observatory was, that its value as a depart-

ment of the university should not be materially affected. This required that it be located within a reasonable distance of Chicago, preferably within a hundred miles.

A committee of the Board of Trustees was appointed to select a site. After visiting the most promising places proposed, this committee reported in favor of accepting a tract of land offered by Mr. JOHN JOHNSON, Jr., of Chicago, situated on the northern shore, near the western end of Lake Geneva, in Southern Wisconsin. In speaking of this tract of land in its report, the committee says: "It is conceded by all concerned that no site thus far suggested combines in itself so many requirements, or any of the requirements, to so great a degree. The site is high and beautifully located. The atmosphere is clear, without danger of encroachments of manufactories, railroads, or electric lights." The Board of Trustees adopted the report of the committee, and the observatory has been built on the land given by Mr. JOHNSON. This tract contains 53 acres. The observatory stands in the midst of it. The center of motion of the great telescope is about 240 feet above the level of Lake Geneva, and about 1800 feet from its shore. The elevation of the site above sea level is about 1200 feet. It is 38 miles from Lake Michigan, and about 75 miles from Chicago. The nearest town is Williams Bay, about a mile distant. This is the terminus of a branch of the Chicago and Northwestern Railway. Lake Geneva, seven miles away, is the nearest town having electric lights. The country round about is woodland and cultivated fields, a beautiful region, already a favorite summer-residence place for people of Chicago.

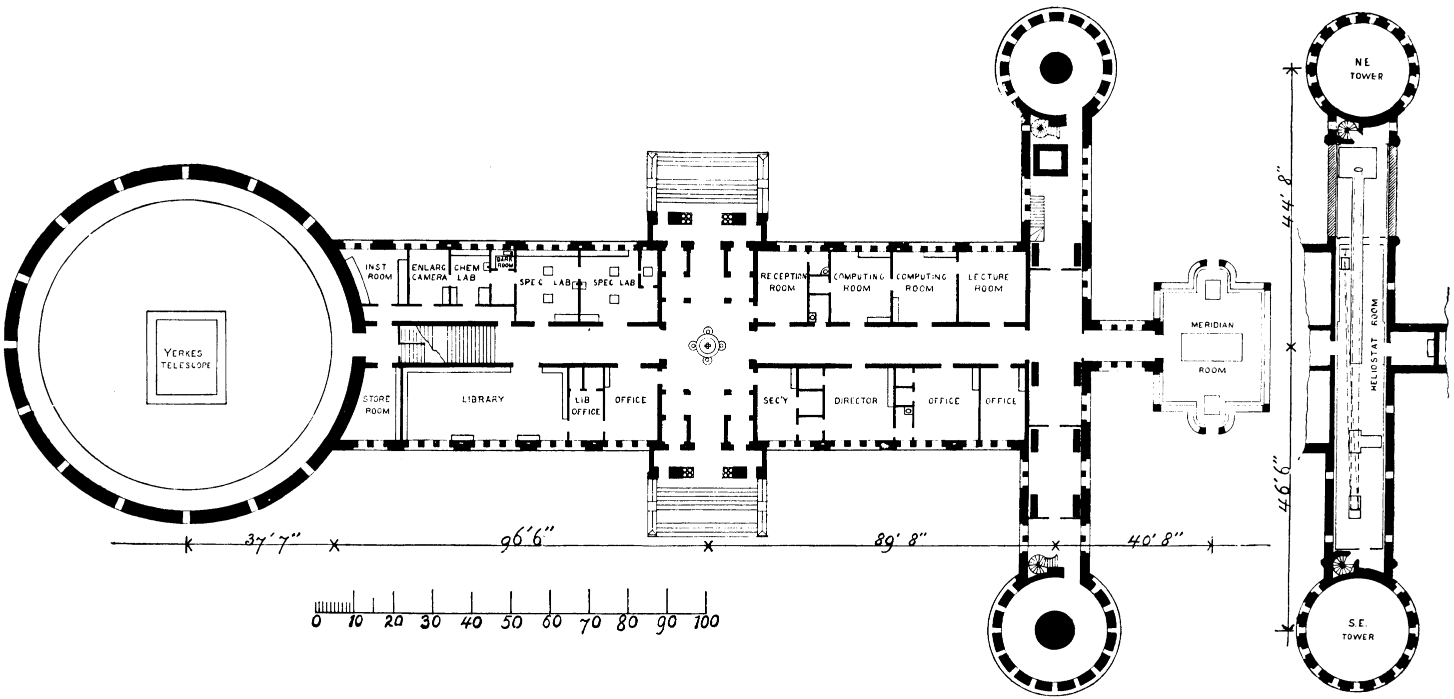
When the lines of work to be pursued by the new observatory had been decided upon, and a site selected which, all requirements considered, promised to be the best, the next problem that confronted Professor HALE was, the plan of an observatory building suited to the scientific requirements and to its environment. To plan such a building was not an easy task. The new observatory was not to be one engaged predominantly with the astronomy of position, nor was it to be merely a spectroscopic laboratory. It was to combine both these lines of work on an extensive scale, and besides to be prepared to meet the needs of such other departments of research as might arise.

The subject was one of such importance that Professor HALE visited and studied the most important observatories and spectroscopic laboratories of the United States and Europe in search of

ideas to enable him to formulate plans embodying the results of experience and meeting the scientific requirements in the most satisfactory manner. The preliminary plans were completed in Berlin in February, 1894, and forwarded to the university architect, Mr. HENRY IVES COBB, of Chicago. During the following year, Mr. COBB worked out the details of the plan with great care, and without sacrificing architectural effect he conserved the scientific requirements. The plans were finally completed in February, 1895, and the work of construction, beginning in April of that year, has since gone on, with some interruptions, until the recent completion of the observatory.

The style of architecture adopted for the main building is Romanesque, with somewhat Saracenic details. The foundation is concrete, and the constructive materials are brown Roman brick with terra-cotta ornaments of the same color. The partitions are of hollow tile, the floors and roof are supported by steel I-beams. The roof is of tile, the floor of the main hall is marble mosaic, and those of the offices and laboratories are maple. The doors and woodwork throughout the building are of antique oak. The form of the building is that of the Latin cross, with the longer axis (326 feet long) lying in an east and west direction, having the tower for the great dome (92 feet in diameter) at the western extremity, and the room for the meridian-circle (28 by 25 feet) at the eastern extremity. For the present, a transit instrument will be used in this room, but it is intended that this shall give place after a time to a large meridian circle. Towers also rise at the ends of the shorter axis of the cross. The northeast tower carries the dome (26 feet in diameter), which was formerly a part of the Kenwood Observatory, and the southeast tower is surmounted by a dome 30 feet in diameter. The 12.2-inch telescope of the Kenwood Observatory is now mounted in the northeast dome. A 24-inch reflecting telescope for stellar spectrographic work is being constructed for use in the southeast dome.

The main entrances to the observatory are on the north and south sides of the building. They are exactly alike, and both lead to the central rotunda. A long hall divides the building centrally lengthwise. The rooms of the main floor have their entrances into this hall or into the rotunda. The rooms on this floor are those designed for offices, computing, reception, and lecture rooms, library, chemical and spectroscopic laboratories, and those for



MAIN FLOOR OF THE YERKES OBSERVATORY.

instruments and storage. The ground floor or basement affords space at the western end for photographic dark rooms and enlarging room, emulsion room, constant temperature room (including space for clocks), physical laboratory, and concave grating room; and at the eastern end for optical, instrument, and pattern shops.

The attic between the two small towers is 104 feet long and 12 feet wide. It is fitted up as a heliostat room. A portion of the roof near the northeast dome is mounted on wheels which run on steel rails. By a windlass this portion of the roof can be drawn to the southward far enough to allow the Sun's rays, at all seasons of the year, to fall upon a heliostat placed near the northern end of the room. A heliostat having a mirror of 24 inches aperture is being made in the shops of the observatory. The large attic rooms along the main axis of the building are so arranged that they can be used in conjunction with the heliostat room for the use of apparatus having lenses or mirrors of great focal length.

The spectroscopic laboratories have solid brick piers on concrete foundations. These are so arranged, with reference to the doors and windows, that the instruments mounted upon them can be used in conjunction with each other, or with instruments in the open air. One of these laboratories is especially arranged for bolometric work. The apparatus for these laboratories includes spectroscopes of various kinds, bolometers, galvanometers, interferential refractometers, induction coils, and a variety of subsidiary apparatus.

The concave grating room is designed to contain a concave grating of 21 feet radius, mounted in the usual manner. At present there are mounted here a 4-inch grating of 10 feet focus and a smaller one of 6 feet focus, both from the Kenwood Observatory. The physical laboratory adjoins the concave grating room, and the latter is so arranged that it can be used in conjunction with apparatus in the former. Both are provided with rolling wooden shutters so that the light can be effectually excluded.

At the Kenwood Observatory, Professor HALE found that many of the problems with which he had to deal, involving, as they did, new methods of research, required the construction of instruments of new and special design. While the principal instruments used there were obtained from BRASHEAR and from WARNER & SWASEY, it was found necessary to have a workshop in which nearly the entire time of an instrument maker was

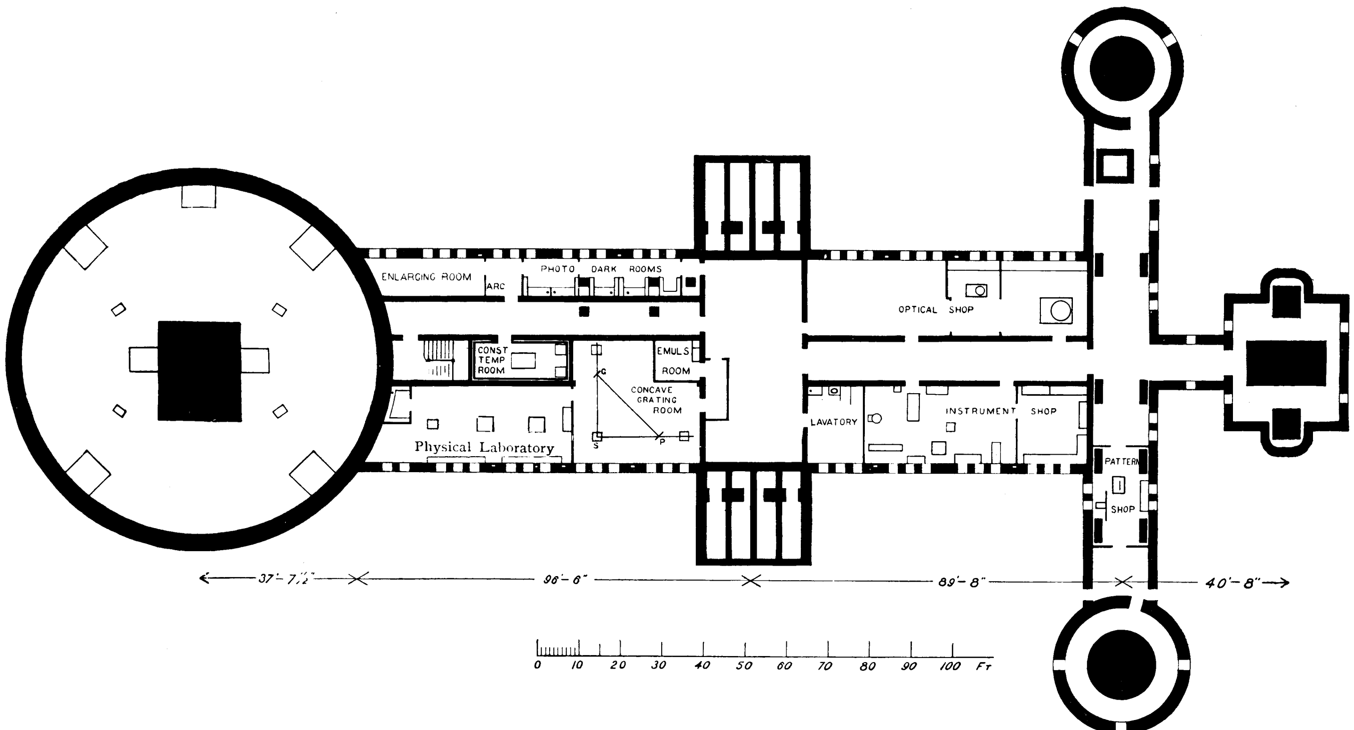
employed in constructing pieces of apparatus required in the solar and spectroscopic work. This shop proved so indispensable to the Kenwood Observatory that it was decided to provide the Yerkes Observatory with the best facilities for mechanical and optical work. A room, 18 by 54 feet, for metal working, was selected on the ground floor of the observatory in the southeast quarter of the building, with smaller adjacent rooms to the east fitted up as a forge room and a pattern shop.

The machine tools used at Chicago were an engine lathe, a shaper, a small speed lathe, an 8-inch Rivett "Precision" lathe, and a Brown & Sharpe universal milling machine. These have been transferred to the new shops, and a planer, a drill press, a circular saw, and speed lathes added.

Two mechanicians are regularly employed in this shop. Several important machines and various pieces of apparatus are in process of construction. A friend of science in Chicago has provided the means of employing a third mechanician for the express purpose of constructing a machine for ruling gratings, according to plans by Professor WADSWORTH.

The optical shop (20 by 70 feet), with rooms fitted up for grinding, polishing and testing lenses and mirrors, is on the north side of the building, just across the hall from the machine shop. The walls of these rooms and the double windows are so constructed as to maintain a nearly constant temperature, a condition necessary for the most successful conduct of the work. Some large pieces of optical work have already been completed in this shop, and still more important ones are planned. A large grinding machine has been constructed under the direction of the observatory optician, Mr. G. W. RITCHEY, for the purpose of grinding and polishing a 60-inch mirror, to be used for stellar spectroscopic work. The work of rough grinding has already been undertaken.

The 40-inch telescope, with its dome and elevating floor, are the principal attractions of the Yerkes Observatory, viewed from a popular standpoint. These are the largest in the world. The dome is 90 feet in diameter, 60 feet high above the top of the tower upon which it rests, or 112 feet above the ground. Its framework is of steel, riveted together. This is covered, first, with a sheathing of wood, and next with roofing tin. It is supported upon 36 wheels, each 36 inches in diameter, and is turned by an endless cable which passes around the dome and is connected with the driving mechanism. The cable is driven



GROUND FLOOR OF THE YERKES OBSERVATORY.

by an electric motor, controlled by a switch on the observing floor. Provision is also made for revolving the dome by hand. The wheels upon which the dome revolves have journals with roller bearings for relieving the friction, and are so constructed as to adjust themselves to possible inequalities of the track.

The observing slit is 13 feet wide, and extends from the horizon to a point 5 feet beyond the zenith. The shutters covering this opening are arranged to open simultaneously on either side, and remain parallel in all positions. Adjustable canvas curtains are placed within the opening to protect the telescope, in whatever direction it may be pointed, from the wind.

It is of interest to compare this dome with the one the next largest; namely, that of the Lick Observatory. The large dome at Mt. Hamilton has an outside diameter of 74 feet 4 inches, and an inside diameter of 71 feet, and weighs, including shutters and live ring, 99½ tons. The live ring itself weighs 12½ tons. This dome rises 41 feet 8 inches above the top of the supporting tower, and 76 feet 10 inches above the ground. The dome is supported on a live ring consisting of 21 conical rollers, each roller having three wheels. The base plate of the dome rests on the central wheel of each group, while the outside wheels rest upon the lower track. The two rails of this track are a part of a conical surface with its apex in the vertical axis of the dome, and in the plane with the tops of the rollers. The upper track is a plane surface. The outside wheels of the live ring are 30 inches in diameter, and the inside ones 28½ inches. The three wheels of each roller were pressed on a steel spindle 3½ inches in diameter, and the journals at the extremities of these spindles are provided with roller bearings for avoiding sliding friction. The framework of the dome is of steel construction, and it is covered with galvanized steel plates.

The observing slit is 9 feet 6¾ inches in the clear, and extends from near the horizon to a point 3½ feet beyond the zenith. This opening is closed with double shutters, hinged at a point beyond the zenith, and supported on wheels resting on a track below. These shutters open simultaneously, but do not remain parallel. The dome is turned by a cable, operated by an hydraulic engine. It may also be turned by hand.

The elevating floor of the Yerkes Observatory is 75 feet in diameter, and rises through 22 feet. It is supported by wire cables, 90° apart. These cables pass over large drums, and are

attached to counterweights. Gearing connects the four drums, causing them to operate simultaneously. The floor is operated by an electric motor, controlled by a switch on the floor. The rising floor of the Lick Observatory was the first one installed. It is 61½ feet in diameter, and rises through 16½ feet. It is operated by hydraulic rams placed 90° apart, and is provided with gearing to keep the floor level in all positions. This method of operation was out of the question at the Yerkes Observatory on account of the danger of the water in the rams freezing in the severe winter weather at Lake Geneva. At Mt. Hamilton the temperature is usually above 32° Fahrenheit, even in winter, and there is seldom any danger from freezing.*

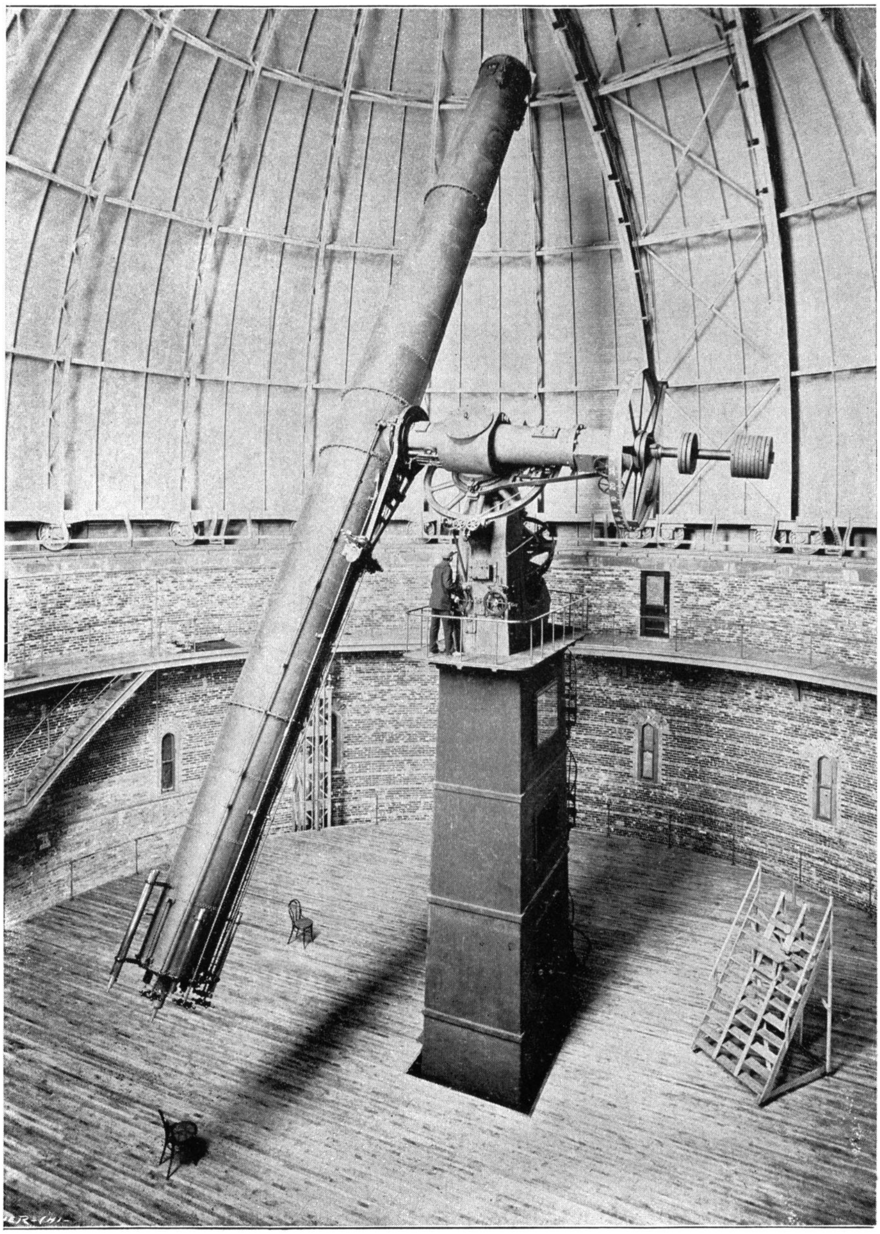
The objective of the Yerkes telescope is 40 inches in diameter, and has a focal length of 62 feet. The crown lens is 2½ inches thick at the center, and ¾ inch at the edge, and weighs 200 pounds. The flint lens is about 1½ inches thick at the center, and 2 inches at the edge, and weighs more than 300 pounds. The two lenses are mounted 8⅜ inches apart, upon aluminum bearings in a cast-iron cell. The total weight of the objective in its cell is about 1000 pounds.

The objective was completed in September, 1895, and tested in the following month at the CLARKS' factory at Cambridgeport, Mass., by Professors HALE and KEELER. Professor KEELER acted as "expert agent" in making the test, and in his report he states:—

"The expanded star disk was round inside and outside of the focus, uniformly illuminated, and free from wings or other appendages. Good images at the focus were obtained of stars at widely different altitudes near the meridian, the definition being,

* The following table is derived from the record of the minimum thermometer at the Lick Observatory. It gives a summary of the lowest temperatures for the past six years. The months considered are from November to March, inclusive, the five coldest months of the year.

WINTER.	MIN. TEMP.	AV. MIN.	NUMBER OF DAYS WHEN TEMPERATURE FELL BELOW			
			20°	25°	30°	32°
1891–92	+17°	+38°	2	5	22	33
92–93	22	37	0	9	32	59
93–94	16	36	4	16	45	56
94–95	22	39	0	4	24	40
95–96	18	39	1	7	28	36
96–97	18	34	2	14	42	52



THE FORTY-INCH YERKES TELESCOPE, MAY 11, 1897.

in my opinion, with due allowance for atmospheric disturbance, equal to that of the Lick telescope, while the brightness of the image was, of course, considerably greater than with the latter instrument. . . . . The color correction of the 40-inch objective is, according to my best recollection, almost precisely the same as that of the Lick telescope."

The tube of the telescope is 60 feet long. It has a diameter of 52 inches at the center, 42 inches at the objective, and 38 inches at the eye-end. It is made of sheet steel, increasing in thickness from 1/8 inch at the ends to 7/32 at the center. It weighs 6 tons, and is so designed that it is in perfect balance when a spectroscope weighing half a ton is attached to the eye-end. When the spectroscope is removed, as for micrometer work, the balance is restored by clamping weights near the eye-end.

The polar and declination axes are of hard forged steel. The former is 13½ feet long, 15 inches in diameter at the upper bearing, and 12 inches at the lower bearing, and weighs 3½ tons. The latter is 11½ feet long, 12 inches in diameter, and weighs 1½ tons. The bearings of these axes are relieved by live rings of steel rolls, to reduce the friction.

The telescope is supported by a cast-iron column, made in sections, bolted together, and firmly anchored to a massive brick pier resting on a concrete foundation. The equatorial head at the top of the column is cast in a single piece, and rises 43 feet above the lowest position of the moving floor. The column and head together weigh 50 tons. An iron balcony surrounds the head. It is accessible from the floor by means of a spiral stairway at the south side of the column. The driving clock is placed within the column, and is accessible by this stairway. An electric motor automatically winds the clock when the weight reaches a point near the limit of its run.

The clamps and slow motions can be operated by an observer at the eye-end, or by an assistant on the balcony. Rapid motions are also provided, as well as a complete system of electric motions, clamps, and illumination. The accessories are a filar micrometer by WARNER & SWASEY, a solar spectroscope and spectroheliograph from designs by Professors HALE and WADSWORTH, and a stellar spectroscope designed and constructed by BRASHEAR.

The objective of the Lick telescope is 36 inches in diameter, and has a focal length of 57 feet 10 inches. The crown

lens is 1.96 inches thick at the center and 0.60 inch at the edge. The flint lens is 0.93 inch thick at the center and 1.65 inches at the edge. The two lenses are mounted about 6½ inches apart, and the total weight of the objective in its cell is 532 pounds.

The tube is 52 feet long, 48 inches in diameter at the center and 38 inches at the ends. It is constructed of sheet steel, 3/16 inch thick at the center and diminishing to ⅛ inch at the ends. The tube has an extension at the eye-end of smaller diameter. This is nearly 3 feet long, and is arranged to carry the sleeve for supporting spectroscopes, photographic apparatus, and the draw tube for the micrometer. The weight of the tube and attachments is 5.3 tons.

The polar and declination axes are of steel; the former is 10 feet long, 12 inches in diameter, and weighs with its attachments 2½ tons; the latter is 10 feet long, 10 inches in diameter, and weighs, with its attachments, 2 tons. The total weight that moves when turning in declination is 7¼ tons, and when moving in right ascension is 14½ tons (28,847 pounds).

The iron columns and heads of the Lick and Yerkes telescopes are similar in design. The head and attachments of the former weigh 6½ tons, the column 19 tons, and the driving clock 1 ton, and total weight of its stationary parts 26¼ tons. The driving clock is wound by a water motor.

In considering the great telescopes of the Yerkes and Lick Observatories, the large increase in the dimensions and massiveness of the former, as compared with the latter, stands in striking contrast with the comparatively small increase in the diameter and focal length of the objective. The objectives differ only 4 inches in diameter and about 4 feet in focal length; the Yerkes telescope weighs 75 tons, and the Lick telescope 41 tons; the elevating floor of the former is 75 feet in diameter and weighs 37½ tons, that of the latter is 61½ feet in diameter and weighs 26 tons; the dome of the former is 90 feet in diameter and weighs 140 tons, while that of the latter is 75 feet in diameter and weighs 99½ tons. The principal reason that the differences are so great is, that the Yerkes telescope has been designed to carry an exceedingly long and heavy solar spectroscope, and other large instruments at the eye-end. This

made it necessary to increase the height and massiveness of the mounting, the distance through which the moving floor rises and falls, and the available floor space beyond what would otherwise have been ample.

Leaving out of account the question of absorption as dependent upon the thickness of the lenses, the perfection with which they are polished, and the quality of the glass of which they are made, in so far as it affects transparency, the light gathering power of the Yerkes telescope is to that of the next largest telescope in the ratio of 100 to 81, or very nearly in the ratio of 5 to 4. This is a difference which, other things being equal, will give it a great advantage over all other instruments in many kinds of work. The magnitudes of the faintest stars visible in the Yerkes and Lick telescopes are (neglecting absorption) respectively 17.21 and 16.98*, or the difference is less than a quarter of a magnitude. In defining power, as exemplified in the separation of close double stars, the two instruments stand in the ratio of 10 to 9; the theoretical limit of separation for the former is $0''.12$ and that for the latter $0''.13$†. These limits differ so little, and are in themselves so small, that in defining power the one telescope has scarcely any advantage over the other for the work here considered. Besides, the practical realization of these limits, aside from the skill of the observer, will depend almost entirely upon atmospheric conditions, particularly upon the steadiness of images and the excellence of the seeing.

The Yerkes Observatory is valued at about $400,000. The large objective cost $66,000; the mounting, $55,000; the dome and elevating floor, $45,000; the stellar spectroscope, $3000; the building, power house, engines, dynamos, etc., more than $145,000. These were the gifts of Mr. YERKES. Mr. JOHNSON'S gift of land is valued at $50,000; Mr. W. E. HALE'S gift of the Kenwood Observatory, $30,000; Miss BRUCE has given $7000 for a 10-inch photographic telescope.

The Lick Observatory cost nearly $600,000. The objective of the 36-inch telescope cost $50,000; the third lens (photographic corrector), 33 inches in diameter, $13,000; the mount-

* This assumes that the faintest star visible in a 1-inch telescope is 9.2 magnitude.

† This assumes, as usual, that the spurious disk of a star in a 12-centimeter telescope is $1''$ in diameter.

ing, $42,000; the elevating floor, $13,000; and the large dome, $54,000.*

In his address at the dedication, President HARPER, quoting the Director, said: "The policy of the Yerkes Observatory will be: (1) To derive the greatest possible return from the use of the great telescope. It is evident that special attention should be given to micrometrical observations of stars, satellites, comets, nebulæ, etc.; solar investigations, both visual and photographic; and spectroscopic researches on the nature of the stars and their motion in the line of sight. (2) To provide for the investigation of any phase of an astronomical or related physical problem. Most American observatories are unprovided with the instruments and laboratories necessary for the interpretation of the phenomena constantly encountered in spectroscopic observations of the heavenly bodies. Spectroscopic laboratories, on the other hand, are not equipped to carry their investigations beyond the artificial boundaries of physics into the realm of astronomy. It is hoped that the Yerkes Observatory may ultimately be in a position to represent both the astronomical and physical sides of astrophysical work, and at the same time provide the best facilities for research work in astronomy of position."

The illustrations accompanying this article are from *The Astrophysical Journal.* They were obtained through the courtesy of Professor HALE.

LICK OBSERVATORY, Mt. Hamilton, Cal.,
November 23, 1897.

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*At the present time the prices of telescopes of various sizes, without their domes and buildings, are roughly as follows, varying much, of course, with the style of mounting, the accessories provided, and the quality of the workmanship. The accessories here included are micrometer, spectroscope, finder, and eye pieces.

DIAMETER OF OBJECTIVE.	PRICE OF OBJECTIVE.	PRICE OF MOUNTING.	ACCESSORIES.	TOTAL.
45 inches	$80,000	$65,000	$4,000	$149,000
40 "	66,000	55,000	4,000	125,000
36 "	40,000	40,000	4,000	84,000
30 "	25,000	30,000	3,500	58,500
24 "	14,000	20,000	3,000	37,000
20 "	9,000	9,000	2,500	20,500
16 "	4,500	6,500	2,500	13,500
12 "	2,000	4,500	2,000	8,500